

Supporting Information

Kivell and Schmitt 10.1073/pnas.0901280106

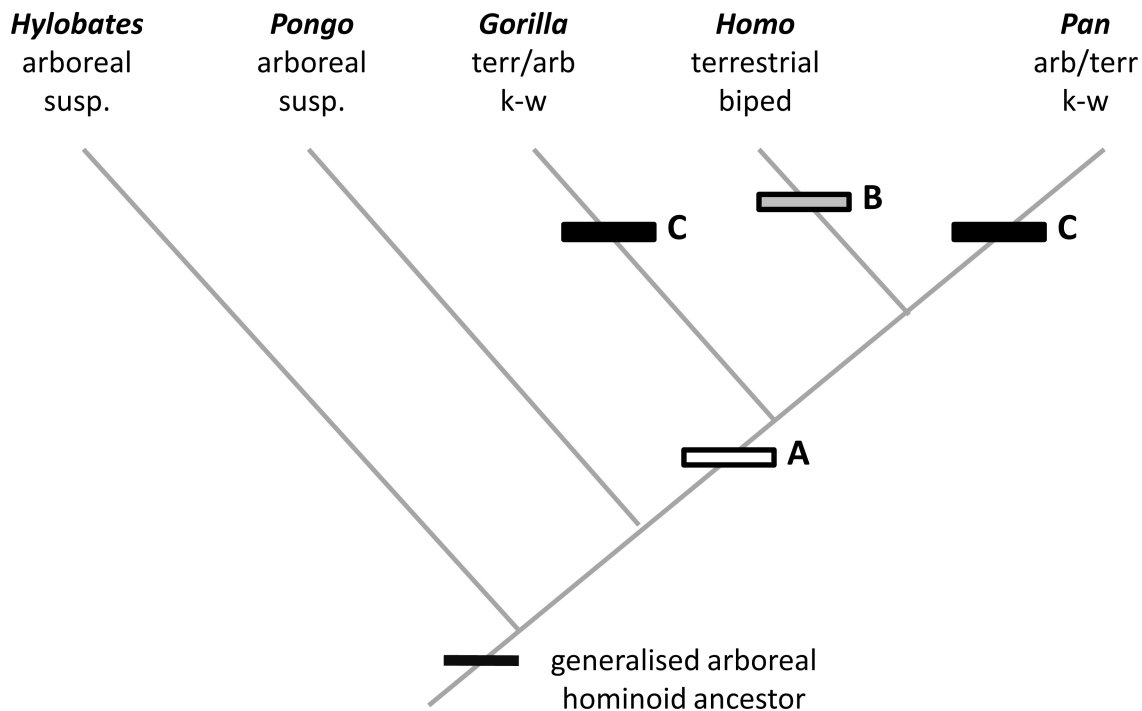


Fig. S1. Phylogenetic and functional hypotheses related to evolution of knuckle-walking locomotion. A cladogram depicting the accepted evolutionary relationships among hominoids (1, 2) and the 2 most commonly debated scenarios for the evolutionary origin of bipedalism: (i) knuckle-walking locomotion evolves at the base of the hominine (African apes and humans) clade (A) and then bipedalism (B) evolves from a knuckle-walking ancestor in the *Homo* clade, sometime after the divergence from *Pan* or, (ii) knuckle-walking evolves independently in *Gorilla* ("columnar" knuckle-walking) and *Pan* ("extended wrist posture" knuckle-walking) (C) and human bipedalism (B) evolves from a more arboreal hominoid ancestor (circle). "Arb," arboreal; "Terr," terrestrial; "Susp," suspensory; "k-w," knuckle-walking.

1. Shoshani J, Groves CP, Simons EL, Gunnell GF (1996) Primate phylogeny: Morphological vs. Molecular Results. *Mol Phylogen Evol* 5:102–154.
2. Page SL, Goodman M (2001) Catarrhine phylogeny: noncoding DNA evidence for a diphyletic origin of the mangabeys and for the human-chimpanzee clade. *Mol Phylogen Evol* 18:14–25.

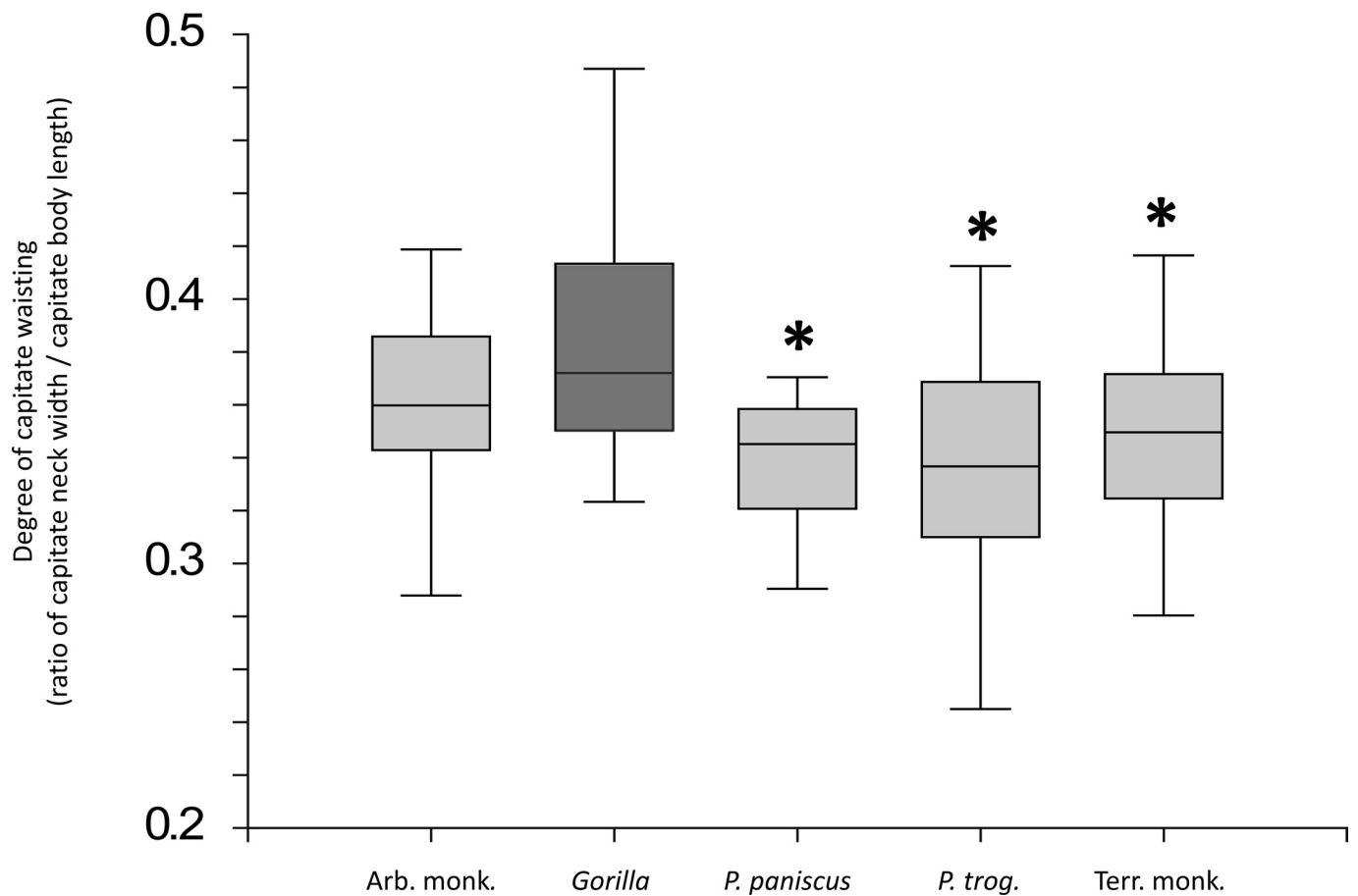


Fig. S2. Degree of capitate waisting in adult African apes and monkeys. Box-and-whisker plot of the ratio of the breadth of the capitate neck divided by the proximodistal length of the capitate body quantifying the relative degree of waisting in each group. Although a strong degree of waisting is considered a knuckle-walking feature that limits extension at the midcarpal joint, *Gorilla* (darker box) shows the least amount of waisting and is significantly (* less than $P = 0.05$) less than *P. paniscus*, *P. troglodytes*, and terrestrial monkeys. Box represents 25th and 75th percentiles, center line is the median and whiskers represent nonoutlier range.

Table S1. Maximum adult and juvenile (Stage 1–7) sample sizes. Composite samples are as follows: "Gorilla" includes *G. gorilla* and *G. beringei*; "Pongo" includes *P. abelii* and *P. pygmaeus*; "Hylobates" includes several of both gibbon and siamang species; "Arb. monk." (arboreal monkey) includes *Macaca fascicularis* and *Cercopithecus*; and "Terr. monk" (terrestrial monkey) includes *Papio*, *Erythrocebus* and *M. mulatta* (* denotes cadaveric specimen)

Taxon							
Stage	<i>P. paniscus</i>	<i>P. trogl.</i>	<i>Gorilla</i>	<i>Pongo</i>	<i>Hylobates</i>	Arb. monk.	Terr. monk.
Adult	21	32	45	32	44	18	25
♂, ♀	10,11	16,16	26,19	13,19	21,23	9,9	12,13
1		1*	1*	1		1	
2	1	3	2				
3	2	7	10	2		2	
4	4	12	15	6	4	6	10
5	3	19	7		2	3	4
6	5	22	5	7	8	10	18
7	7	8	6	5	1	4	4

Table S2. Quantitative results of the frequency of putative knuckle-walking features in the African ape and monkey wrist. (a) Chi-square goodness-of-fit results for pairwise African ape species comparisons of the frequency of putative knuckle-walking features. Significantly different ($P < 0.05$) population frequencies are shown in bold. Note that *Gorilla* is significantly different from both *P. troglodytes* (*P. trog.*) and *P. paniscus* in the frequency of all traits listed here. No significant differences in the frequency of the capitate and hamate distal concavities were found among African apes. (b) Frequency of putative knuckle-walking carpal features in nonknuckle-walking adult arboreal (including *M. fascicularis* and *Cercopithecus*) and terrestrial (including *Papio*, *Erythrocebus* and *M. mulatta*) quadrupedal monkeys

Species	Traits		
Adults	Scaphoid beak and dorsal concavity	Capitate ridge	Hamate ridge
<i>P. trog. vs. P. paniscus</i>	$\chi^2 = 1.222$; $P = 0.269$	$\chi^2 = 1.887$; $P = 0.170$	$\chi^2 = 1.210$; $P = 0.271$
<i>P. trog. vs. Gorilla</i>	$\chi^2 = 39.231$; $P > 0.000$	$\chi^2 = 9.153$; $P = 0.002$	$\chi^2 = 14.226$; $P > 0.000$
<i>P. paniscus vs. Gorilla</i>	$\chi^2 = 40.390$; $P > 0.000$	$\chi^2 = 8.790$; $P = 0.003$	$\chi^2 = 13.873$; $P > 0.000$
Juveniles			
<i>Pan vs. Gorilla</i>	$\chi^2 = 12.214$; $P > 0.000$	$\chi^2 = 8.410$; $P = 0.004$	$\chi^2 = 36.714$; $P > 0.000$

Species group	Traits					
	scaphoid		capitate		hamate	
	Beak	Dorsal concavity	Distal concavity	Ridge	Distal concavity	Ridge
Arboreal monkeys Palmigrade (<i>n</i> = 18)	93%	80%	0%	47%	100%	73%
Terrestrial monkeys	100%	57%	0%	50%	100%	92%
Digitigrade (<i>n</i> = 14)						
Palmigrade (<i>n</i> = 11)	100%	73%	25%	50%	83%	92%